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Differences in Inflammation, Treatment and Outcomes between Black and non-Black Patients Hospitalized for COVID-19: A Prospective Cohort Study

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Clinical Research Study

**Differences in Inflammation, Treatment and Outcomes between  
Black and non-Black Patients Hospitalized for COVID-19: A  
Prospective Cohort Study**

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**Clinical Significance Bullet Points:**

- Black patients hospitalized with COVID-19 are less likely to receive corticosteroids and remdesivir than non-Black patients.
- Black patients are less likely to be enrolled in clinical trials for COVID-19.
- Black race is independently associated with need for mechanical ventilation, but this relationship is abrogated when adjusted for use of corticosteroids and remdesivir.

**ABSTRACT**

**Purpose:** Racial disparities in COVID-19 outcomes have been described. We sought to determine whether differences in inflammatory markers, use of COVID-19 therapies, enrollment in clinical trials, and in-hospital outcomes contribute to racial disparities between Black and non-Black patients hospitalized for COVID-19.

**Methods:** We leveraged a prospective cohort study which enrolled 1325 consecutive patients hospitalized for COVID-19, of whom 341 (25.7%) were Black. We measured biomarkers of inflammation and collected data on the use COVID-19-directed therapies, enrollment in COVID-19 clinical trials, mortality, need for renal replacement therapy, and need for mechanical ventilation.

**Results:** Compared to non-Black patients, Black patients had a higher prevalence of COVID-19 risk factors including obesity, hypertension, and diabetes mellitus, and were more likely to require renal replacement therapy (15.8% vs. 7.1%,  $P<0.001$ ) and mechanical ventilation (37.2% vs. 26.6%,  $P<0.001$ ) during their hospitalization. Mortality was similar between both groups (15.5% for Blacks vs. 14.0% for non-Blacks,  $P=0.49$ ). Black patients were less likely to receive corticosteroids (44.9% vs 63.8%,  $P<0.001$ ) or remdesivir (23.8% vs. 57.8%,  $P<0.001$ ), and were

less likely to be enrolled in COVID-19 clinical trials (15.3% vs. 28.2%,  $P<0.001$ ). In adjusted analyses, Black race was associated lower levels of C-reactive protein and soluble urokinase receptor, and higher odds of death, mechanical ventilation and renal replacement therapy. Differences in outcomes were not significant after adjusting for use of remdesivir and corticosteroids.

**Conclusions:** Racial differences in outcomes of patients with COVID-19 may be related to differences in inflammatory response and differential use of therapies.

**KEY WORDS**

African Americans; Convalescent serum; remdesivir; corticosteroids; M2C2; SARS-COV-2, Coronavirus, disparities

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## Introduction

The Coronavirus 19 Disease (COVID-19) pandemic has disproportionately affected minorities in the United States<sup>1,2</sup>. The prevalence of COVID-19 is higher in Black patients relative to other racial groups<sup>3</sup>, and Black patients have a higher prevalence of risk factors for severe COVID-19, including obesity, hypertension, diabetes mellitus and kidney disease compared to non-Black patients.<sup>4,5,6,7</sup> However, reports on the association between Black race and worse COVID-19 outcomes have been discrepant. Nationwide data suggest Black patients account for a higher percentage of deaths relative to their representation in the general population<sup>8</sup>. However, a recent cohort study of over 11,000 patients presenting to hospitals across the country found that there was no difference in in-hospital mortality between Black and White patients, even after accounting for age, gender, co-morbidities, and markers of socioeconomic status<sup>9</sup>. Another recent study found that while Black and Hispanic patients were more likely to test positive for SARS-CoV-2, rates of hospitalization were similar compared to White patients, and Black patients were less likely to die or be discharged on hospice care after adjusting for comorbidities and neighborhood characteristics<sup>10</sup>.

Whether differences in COVID-19-related hospitalization outcomes between Black and non-Black patients relate to variations in levels inflammatory markers or use of COVID-19 directed therapies is unclear. Most studies examining racial differences related to COVID-19 are derived from administrative databases limited by the lack of clinical detail in characterizing patients hospitalized for COVID-19. Black patients have been previously reported to receive sub-optimal treatment as compared to White patients in a variety of settings, including following admission for pneumonia<sup>11</sup> and in-hospital cardiac arrest<sup>12</sup>. Minority groups have also been historically

underrepresented in clinical trials<sup>13–15</sup>, an especially important consideration given the implications for the generalizability of COVID-19 directed therapeutics<sup>16</sup>.

The main objective of this study is to understand the reasons underlying apparent racial disparities related to COVID-19, through detailed characterization of the clinical course of Black and non-Black patients hospitalized for COVID-19, including differences in co-morbidities, levels of inflammatory markers, use of COVID-19-directed therapies and participation in clinical trials. We leveraged the Michigan Medicine COVID-19 Cohort (M<sub>2</sub>C<sub>2</sub>), a large prospective cohort in which patient hospitalized specifically for COVID-19 were identified and systematically enrolled and characterized.



## Methods

### Study Design

The Michigan Medicine COVID-19 Cohort (M<sub>2</sub>C<sub>2</sub>) is an ongoing prospective cohort study initiated in February of 2020 which enrolls consecutive adults ( $\geq 18$  years) with confirmed SARS-CoV-2 infection who were hospitalized specifically for COVID-19 at the University of Michigan. Patients with a positive test for SARS-CoV-2 hospitalized primarily for non-COVID-19 reasons were excluded. Patient eligibility for inclusion into M<sub>2</sub>C<sub>2</sub> was reviewed by two independent physicians at the time of admission. Manual chart review and data mining tools were used to gather details of the presentation, demographics, past medical history, home medications, laboratory studies, inpatient medical therapy, hospitalization course and outcomes. Residual biological samples were collected for biomarker testing. All patients were followed until hospital discharge or in-hospital death. The study was approved by the University of Michigan Institutional Review Board. The dataset for this study included patients enrolled in M<sub>2</sub>C<sub>2</sub> from February 1<sup>st</sup>, 2020 to March 26<sup>th</sup>, 2021.

### Exposures and Outcomes

The primary exposure was race as documented in the medical record; categorized as non-Hispanic Black versus non-Black patients. We collapsed non-Hispanic White (61.8%), Asian (4.7%), Hispanic (2.5%) and other races (5.3%) into a single “non-Black” category due to their limited numbers.

The outcomes examined were in-hospital death or discharge to hospice, need for mechanical ventilation, and need for renal replacement therapy during hospitalization.

Treatment for COVID-19 was defined as the receipt of any doses of the following therapies: corticosteroids, remdesivir, azithromycin, hydroxychloroquine, tocilizumab, therapeutic anticoagulation (specifically excluding anticoagulation for venous thromboembolism prophylaxis only), and convalescent serum. We also collected data on participation in COVID-19 related clinical trials.

Data on the following inflammatory markers measured within 48 hours of admission were collected: soluble urokinase plasminogen activator receptor (suPAR), C-reactive protein (CRP), interleukin-6 (IL-6), D-dimer, ferritin, lactate dehydrogenase (LDH) and procalcitonin.

### **Laboratory Measures**

Data on levels of CRP, D-Dimer, ferritin, LDH, and procalcitonin measured within 48-hours of presentation were extracted from the medical record. We measured suPAR in plasma using a commercially available enzyme-linked immunosorbent assay (SuPARnostic assay by ViroGates, Birkerød, Denmark) in residual samples obtained from the clinical laboratory. The lower detection limit of the assay is 100 pg/ml with minimal intra- and inter-assay variation (2.75% and 9.17%) per the manufacturer. We measured IL-6 with an enzyme-linked immunosorbent assay (Quantikine® QuicKit™ ELISA, Human IL-6 Immunoassay, Minneapolis, Minnesota). The IL-6 assays have a lower detection limit of 1.70 pg/mL and intra- and inter-assay variation of 2.6% and 4.5% respectively, as reported by the assay manufacturer.

### **Statistical Analysis**

We first compared clinical characteristics between Black and non-Black patients. Categorical variables were presented as frequencies with percentages while continuous variables were presented as means with standard deviations if normally distributed or medians with interquartile ranges if non-normally distributed. Chi-square tests were used to compare categorical variables

while Student's t-tests and Mann-Whitney U tests were used for normally and non-normally distributed continuous variables, respectively. We also report the use of COVID-19 therapies stratified by period (before and after May 1<sup>st</sup>, 2020 – date of the Emergency Use Approval of remdesivir by the United States Food and Drug Administration).

To determine whether racial differences between biomarker levels were independent of clinical characteristics, we used multivariable linear regression models where each biomarker was evaluated separately as the dependent variable and included race as an independent variable. Clinical characteristics included as covariates in each model were: age, gender, body-mass index (BMI), diabetes mellitus, hypertension, coronary artery disease, heart failure and creatinine-derived estimated glomerular filtration rate (eGFR) on admission.

To assess whether Black race was independently associated with outcomes -- notably in-hospital death, need for mechanical ventilation, and need for dialysis – and assess the impact of select confounders on the association, we used binary logistic regression with stepwise modeling and each outcome as the dependent variable. Model 0 included race alone; model 1 (clinical characteristics) included race, age, gender, BMI, diabetes mellitus, hypertension, coronary artery disease, heart failure, chronic kidney disease, and eGFR on admission. Model 2 (inflammation) added CRP to model 1, and model 3 (COVID-19 therapies) added use of remdesivir and corticosteroids to the variables in Model 1.

Similarly, we used logistic regression to examine the association between race (independent variable) and the use of COVID-19 therapies; notably remdesivir and corticosteroids (dependent variables in separate models). We included the following covariates in each model: age, sex,

BMI, diabetes mellitus, hypertension, coronary artery disease, heart failure, and eGFR on admission. All analyses were performed in SPSS Statistics 27 (IBM, Armonk, NY).

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## Results

### *Differences in Clinical Characteristics between Black and non-Black patients*

At the time of database lock for the purpose of this study (March 26<sup>th</sup>, 2021), a total of 1325 patients (mean age 61 years, 57.1% male) had been hospitalized for COVID-19 at the University of Michigan Health System, comprising 341 (25.7%) Black patients and 984 (74.2%) non-Black patients. White individuals represented the majority of non-Black patients (n=819, 83.2%), followed by Asian (n=62, 6.3%), other/unknown race (n=70, 7.1%) and Hispanic (n=33, 3.4%).

Black patients were on average younger than non-Black patients and had higher average BMI (Table 1). The prevalence of cardiovascular and COVID-19 risk factor rates was higher in Black patients compared to non-Black patients: hypertension (75.7% vs 59.0%,  $P<0.001$ ), diabetes mellitus (48.1% vs 35.6%,  $P<0.001$ ), and chronic kidney disease (22.6% vs 16.8%,  $P=0.017$ ) (Table 1).

### *Clinical Presentation*

Frequency of respiratory symptoms on presentation of COVID-19 was similar between Black and non-Black patients, with no significant differences in cough, shortness of breath, fever, or altered mental status. Black patients were, however, more likely to have diarrhea on presentation (34.0% vs 27.1%,  $P = 0.016$ ) (Table 1).

Black patients had a higher mean creatinine (2.4 mg/dL vs 1.6 mg/dL,  $P = 0.007$ ) and aspartate aminotransferase (64 IU/L vs 57 IU/L,  $P=0.025$ ) on admission than non-Black patients. There were no significant differences in hemoglobin, white blood cell count, absolute neutrophil/lymphocyte count, aspartate aminotransferase, or total bilirubin (Table 1).

### ***Inflammatory Markers***

In univariable analysis, Black patients had higher median C-reactive protein (10.2 mg/dL vs 8.3 mg/dL,  $P<0.001$ ), lactate dehydrogenase (430 IU/L vs 356 IU/L,  $P<0.001$ ), procalcitonin (20.0 ng/mL vs 12.5 ng/mL,  $P<0.001$ ), ferritin (844 ng/mL vs 624 ng/mL,  $P<0.001$ ), and D-dimer (1.34 FEU mg/L vs 0.90 FEU mg/L,  $P<0.001$ ). There were no differences between Black patients and non-Black patients in suPAR or IL-6 levels (Table 1). After adjusting for clinical characteristics and COVID-19 risk factors, Black race was associated with lower suPAR and C-reactive protein levels (Table 2).

### ***COVID-19 Therapies***

Black patients were more likely to receive hydroxychloroquine (31.7% vs 14.3%,  $P<0.001$ ), azithromycin (35.8% vs 23.9%,  $P<0.001$ ), and tocilizumab (15.8% vs 8.8%,  $P<0.001$ ), and less likely to receive remdesivir (23.8% vs 57.8%,  $P<0.001$ ), corticosteroids (44.9% vs 63.8%,  $P<0.001$ ), and convalescent serum (2.9% vs 9.0%,  $P<0.001$ ) than non-Black patients (Figure 1). Black patients were also less likely to be enrolled in any COVID-19 related clinical trial than non-Black patients (15.3% versus 28.2%,  $P<0.001$ ) (Figure 1).

In multivariable analysis adjusting for age, gender, co-morbidities, and eGFR at admission, Black race was independently associated with a lower odds of receiving remdesivir (adjusted odds ratio (aOR) 0.24 [0.18-0.32],  $P<0.001$ ), receiving corticosteroids (aOR 0.45 [0.35-0.58],  $P<0.001$ ), or being enrolled in a COVID-19 clinical trial (aOR 0.47, [0.32-0.68],  $P<0.001$ ) (Table 3). When examining the use of COVID-19 therapies stratified by time period (prior to or after May 1<sup>st</sup>, 2020, the date of Emergency Use Authorization (EUA) of remdesivir), we noted a significant increase in the use of remdesivir and corticosteroids in Black patients (Figure 2), with

differences in their use between Black patients and non-Black patients no longer being significant in the post-EUA.

### ***Outcomes***

Overall mortality in the cohort was 14.4%. While there was no statistically significant difference in mortality between Black patients and non-Black patients (15.5 vs 14.0%,  $P=0.49$ ), Black patients were more likely to require mechanical ventilation (37.2% vs 26.6%,  $P<0.001$ ) and renal replacement therapy (15.8% vs 7.1%,  $P<0.001$ ) (Table 1).

In multivariable analysis, Black race was only associated with increased risk of death after adjustment for inflammation as measured by CRP levels, and the associations with mechanical ventilation and renal replacement therapy were strengthened (Figure 3). Adjustment for the use of remdesivir and corticosteroids eliminated these associations, suggesting that the higher odds of mechanical ventilation and renal replacement therapy in Black patients may have been due to the lower rate of use of these therapies in Black patients prior to May 1, 2020.

### **Discussion**

There has been much debate on the reasons that underlie racial disparities in COVID-19-related outcomes. We shed light on potential causes in this prospective cohort study of patients hospitalized specifically for COVID-19 who were extensively characterized and had measures of inflammation. We found that Black compared to non-Black patients had similar in-hospital death rates despite a higher prevalence of co-morbidities and COVID-19 risk factors, which may be explained by the lower burden of inflammation as measured by CRP and suPAR levels. Black patients were less likely to receive remdesivir and corticosteroids or enroll in clinical trials,

which our data suggest may have impacted their outcomes, as the associations between Black race and the need for mechanical ventilation or renal replacement therapy were obviated after adjustment for the differential use of these therapies. To our knowledge, this is the first study analyzing the interplay between inflammation, treatment, and outcomes as it relates to racial differences in COVID-19.

Throughout the COVID-19 pandemic, racial disparities in infection rates,<sup>17</sup> hospitalization rates<sup>18,19</sup>, and overall mortality<sup>17,20</sup> have been described. These differences are likely closely tied to socioeconomic status, as they are somewhat attenuated after adjustment for risk factors including age, sex, comorbidities, insurance, neighborhood, and access to care. Several studies have shown no differences in in-hospital mortality<sup>9,20,21</sup>. A complex interplay between social determinants of health and associated comorbidity burden has been posited as the basis for the observed disparities in COVID-19 infection rate<sup>22-24</sup>. This study builds on the current body of knowledge by providing data on the impact of underlying inflammation and differing treatments to COVID-19 related outcomes.

A recent review posited that observed racial and ethnic differences in COVID-19 outcomes may arise from a differential inflammatory response between groups, driven by underlying differences in chronic inflammation from different burdens of co-morbidity, socio-economic factors, genetic factors, and psychologic stressors<sup>25</sup>. Differences in chronic inflammation as measured by CRP levels have been previously described, with several studies finding that Black patients have higher median CRP levels than White patients, though these differences were heavily attenuated after accounting for differences in comorbidities and psychosocial factors<sup>26, 27</sup>. Similarly, after adjusting for cardiovascular and COVID-19 risk factors, Black race compared to



non-Black was associated with relatively lower levels of CRP and suPAR, reflecting perhaps an attenuated inflammatory response to SARS-CoV-2 infection and leading to similar survival rates compared to non-Black patients despite their significantly higher burden of co-morbidities. Studies on racial differences in acute inflammation are few. In one study, Black participants exhibited an attenuated inflammatory response compared to non-Blacks when exposed to endotoxin<sup>28</sup>. Nevertheless, these findings warrant further investigation into racial differences in the immune response and their mechanisms.

Our study found substantial treatment differences between Black and non-Black patients that persisted even after multivariable adjustment. Racial disparities in treatment in medicine are well described, in diseases as diverse as pneumonia<sup>29</sup>, cardiac arrest<sup>30</sup>, appendicitis<sup>31</sup>, and end-stage renal disease<sup>32</sup>. At the time of writing, no study has evaluated racial differences in the in-hospital management of COVID-19. These differences in the use of COVID-19 directed therapies such as remdesivir are at least partially related to the lower enrollment of Black patients in clinical trials, as we noted its rate of use dramatically increased to levels that were similar by race after its EUA by the FDA. Disproportionately low enrollment of Black patients in clinical trials has been demonstrated time and again, including in heart failure<sup>33</sup>, multiple myeloma<sup>13</sup>, cancer phase III trials<sup>34</sup>, HIV<sup>35</sup>, and others. Many theories have been proposed for why this disparity has been found, and much of the discussion focuses on reluctance among Black patients, a legacy of the unethical, abhorrent Tuskegee Syphilis study<sup>36</sup>, and investigator bias<sup>37,38</sup>. The reasons for reduced enrollment of Black patients in clinical trials in our study unfortunately could not be ascertained. However, we show that differences in management may have major consequences,

as differences in the incidence of mechanical ventilation and renal replacement therapy were abrogated after adjustment for the use of COVID-19 directed therapies.

Our study has major strengths, including the prospective and systematic inclusion of patients hospitalized specifically for COVID-19, rather than patients hospitalized with a positive SARS-CoV-2 test. We have complemented our assessment of conventional biomarkers of inflammation such as CRP, ferritin, D-dimer, lactate dehydrogenase and procalcitonin with measurements of non-conventional measurements of inflammation such as suPAR and IL-6. We used admission biomarkers levels as opposed to serial measurements to avoid confounding by therapies administered. Serial biomarker measurements may shed light on racial differences to response to therapy. The major limitations are in the observational nature of the study, and the inability to capture reasons for not enrolling in clinical trials, precluding making strong conclusions on the impact of racial differences in management on COVID-19 related outcomes.

In conclusion, our study demonstrates significant differences in inflammation, use of COVID-19 directed therapies, and outcomes, notably the need both mechanical ventilation, renal replacement therapy and death between Black and non-Black patients hospitalized for COVID-19. These findings should prompt additional studies on racial differences in acute inflammation, as well as scrutiny of institutional treatment protocols to reduce racial differences in treatment and clinical trial enrollment.

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**Reproducible Research Statement:** Study protocol, statistical code, and dataset: summary data available upon request after publication through a collaborative process. Researchers should provide a methodically sound proposal with specific objectives in an approval proposal. Please contact [penegonz@med.umich.edu](mailto:penegonz@med.umich.edu) for additional information.

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**Author Contributions:**

TUA and HB wrote the first draft. SSH and TUA performed the statistical analyses. SSH, TUA, HB, EA, MP, HS, KP, PO, CM, RF, EM, CL, PK, and AB collected the data and performed quality control. SSH, TUA, CW, RP, and JC provided expert interpretation of the findings. All co-authors reviewed the initial draft and provided critical revisions. All co-authors had full access to the data and take responsibility for the integrity and accuracy of the data analysis. All authors approved the final version of the manuscript.

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**Table 1. Demographics and Clinical Characteristics by Self-Reported Race**

Variables	Overall Cohort (n=1325)	Non-Black Race* (n=984)	Black Race (n=341)	P- Value
Age, years, mean (SD)	61 (16)	62 (16)	58 (15)	0.001
Male, n (%)	757 (57.1%)	578 (58.7%)	179 (52.5%)	0.045
Body mass index, kg/m <sup>2</sup> , mean (SD)	32 (9)	31 (8)	34 (9)	<0.001
History of tobacco use, n (%)	571 (43.1%)	433 (44.0%)	138 (40.5%)	0.26
Diabetes mellitus, n (%)	514 (38.8%)	350 (35.6%)	164 (48.1%)	<0.001
Hypertension, n (%)	839 (63.3%)	581 (59.0%)	258 (75.7%)	<0.001
Coronary artery disease, n (%)	219 (16.5%)	174 (17.7%)	45 (13.2%)	0.06
Congestive heart failure, n (%)	167 (12.6%)	117 (11.9%)	50 (14.7%)	0.18
Chronic kidney disease, n (%)	242 (18.3%)	165 (16.8%)	77 (22.6%)	0.017
End-stage renal disease on dialysis, n (%)	44 (3.3%)	27 (2.7%)	17 (5.0%)	0.047
Admission eGFR, mean (SD)	67 (32)	69 (30)	64 (37)	0.020
<b>Presenting Symptoms, n (%)</b>				
Fever	790 (59.6%)	577 (58.6%)	213 (62.5%)	0.22
Shortness of breath	990 (74.7%)	733 (74.5%)	257 (75.4%)	0.75
Diarrhea	383 (28.9%)	267 (27.1%)	116 (34.0%)	0.016
Altered mental status	146 (11.0%)	115 (11.7%)	31 (9.1%)	0.19
<b>Laboratory Data**, mean (SD)</b>				
Hemoglobin, g/dL	13.1 (2.2)	13.1 (2.3)	12.9 (2.0)	0.11
White blood cell count, k/uL	7.7 (5)	7.6 (5.3)	8 (3.9)	0.23
Absolute neutrophil count, k/uL	5.9 (4.2)	5.8 (4.5)	6.1 (3.4)	0.29
Absolute lymphocyte count, k/uL	1.2 (3.0)	1.2 (3.4)	1.1 (1.0)	0.50
Aspartate aminotransferase, IU/L	59 (57)	57 (55)	66 (64)	0.025
Alanine aminotransferase, IU/L	46 (52)	47 (53)	44 (50)	0.37
Total bilirubin, mg/dL	0.73 (1.11)	0.72 (1.25)	0.73 (0.56)	0.98
Creatinine, mg/dL	1.8 (4.6)	1.6 (4.9)	2.4 (3.3)	0.007
<b>Inflammatory Markers, median (IQR)</b>				
SuPAR, ng/mL	7.77 (5.46-12.17)	7.89 (5.48-12.28)	7.54 (5.39-12.12)	0.45
C-reactive protein, mg/dL	8.70 (4.70-17.27)	8.30 (4.10-16.30)	10.20 (5.80-18.80)	<0.001
Lactate dehydrogenase, IU/L	376 (277-516)	356 (267-487)	430 (325-588)	<0.001
Interleukin-6, pg/mL	12.50 (12.50-95.00)	12.50 (12.50-87.93)	20.00 (12.50-105.89)	0.19
Procalcitonin, ng/mL	0.18 (0.10-0.48)	0.17 (0.09-0.41)	0.24 (0.11-	<0.001

Ferritin, ng/mL	684 (299-1368)	624 (270-1256)	844 (385-1557)	0.70) <0.001
D-dimer, FEU mg/L	1.00 (0.57-1.98)	0.90 (0.54-1.73)	1.34 (0.73-2.93)	<0.001
<b>Outcomes, n (%)</b>				
Need for mechanical ventilation	389 (29.4%)	262 (26.6%)	127 (37.2%)	<0.001
Need for renal replacement therapy	124 (9.4%)	70 (7.1%)	54 (15.8%)	<0.001
In-hospital death	191 (14.4%)	138 (14.0%)	53 (15.5%)	0.49

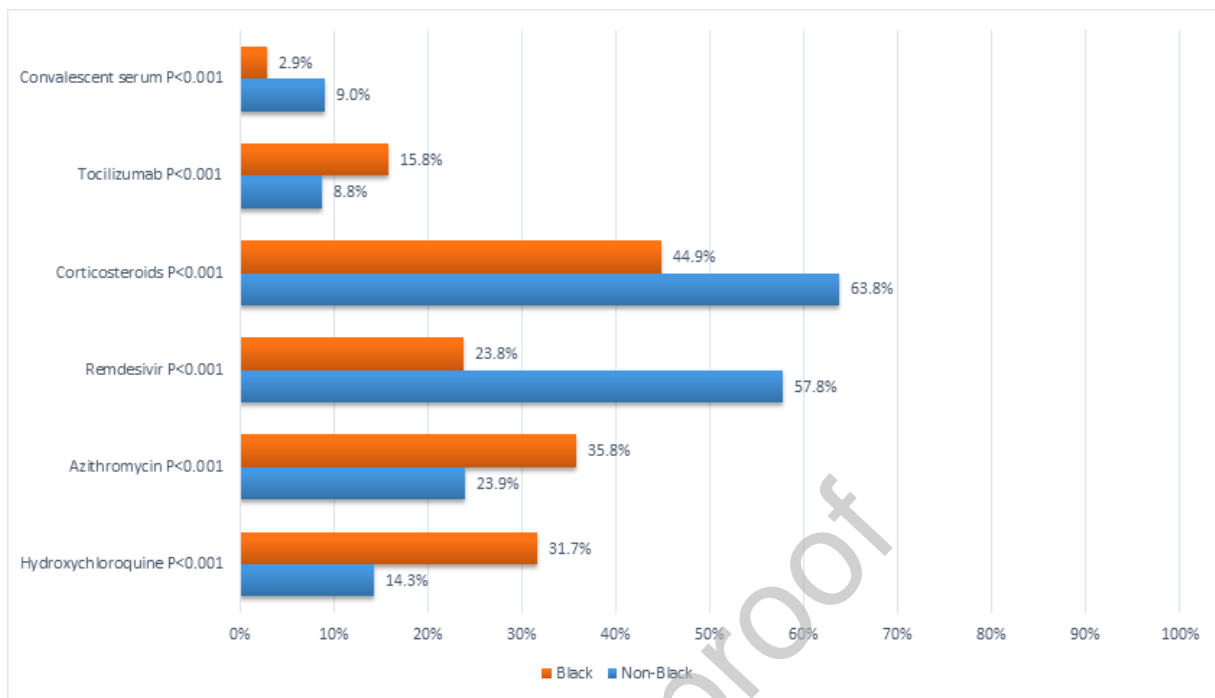
\*Includes 819 White patients, 33 Hispanics, and 62 Asian patients and 70 of unknown race or other. \*\*First value within 48 hours of presentation

**Table 2. Biomarkers of Thrombo-Inflammation and Black race**

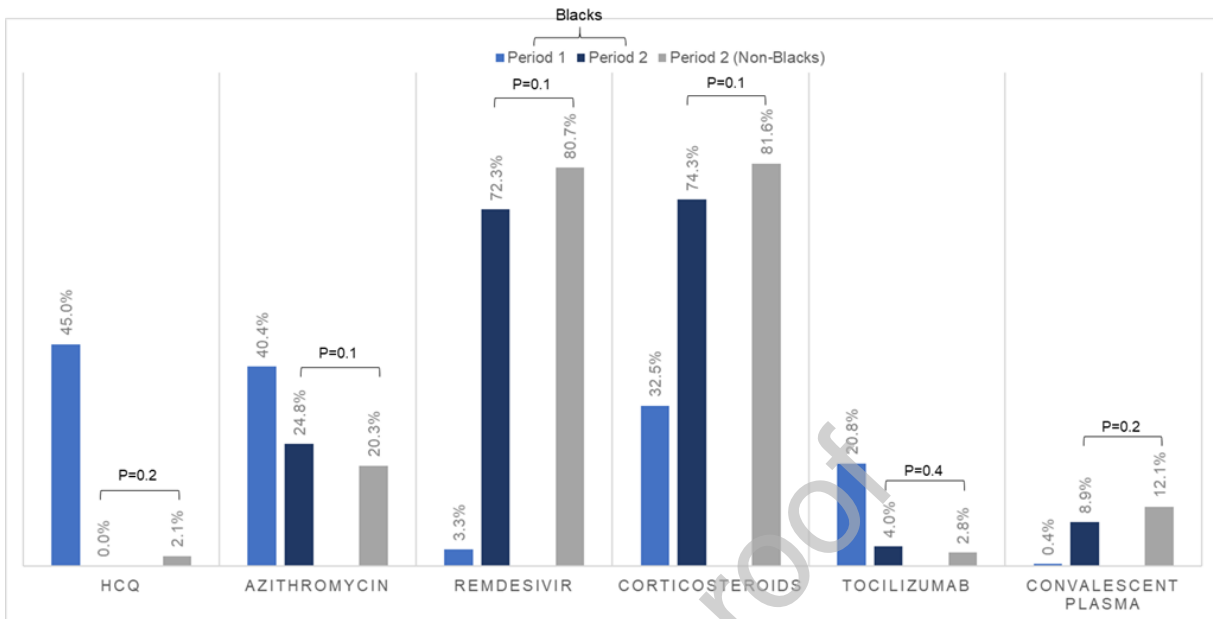
	Biomarker, $\beta$ (95%CI)						
	SuPAR	C- reactive protein	Lactate dehydrogenase	Interleukin- 6	Procalcitonin	Ferritin	D- dimer
Black race	<b>-1.00 (-1.93--0.07)</b>	<b>-7.74 (-13.86--1.61)</b>	<b>73 (31-114)</b>	19.93 (-81.70-121.56)	0.75 (-4.69-6.18)	<b>439 (187-691)</b>	-0.17 (-5.87-5.54)
Age, per 1 year	-0.03 (-0.06-0.00)	-0.20 (-0.41-0.02)	-1 (-3-0)	-2.01 (-5.93-1.91)	0.03 (-0.17-0.22)	-4 (-13-5)	0.09 (-0.11-0.29)
Male gender	-0.67 (-1.52-0.19)	-5.09 (-10.54-0.35)	-42 (-80--5)	-78.68 (-178.31-20.95)	-0.77 (-5.69-4.14)	-522 (-747--297)	-3.68 (-8.74-1.38)
Body-mass index, per 1 kg/m <sup>2</sup>	0.07 (0.02-0.12)	0.05 (-0.29-0.39)	2 (0-5)	0.30 (-6.17-6.76)	-0.16 (-0.46-0.15)	0 (-14-14)	0.39 (0.08-0.71)
Diabetes mellitus	0.54 (-0.39-1.48)	6.20 (0.19-12.21)	-12 (-53-30)	81.59 (-26.96-190.15)	-1.62 (-7.03-3.80)	121 (-127-367)	-1.47 (-7.04-4.09)
Hypertension	-0.68 (-1.69-0.33)	-0.79 (-7.19-5.61)	-54 (-98--9)	-46.49 (-165.83-72.86)	-3.51 (-9.30-2.27)	-204 (-470-62)	-3.53 (-9.51-2.45)
Coronary artery disease	1.03 (-0.20-2.26)	-8.49 (-16.49-0.50)	-37 (-92-18)	-33.86 (-174.29-106.57)	-0.79 (-7.85-6.26)	-113 (-439-213)	-0.42 (-7.84-7.01)
Heart failure	0.62 (-0.71-1.94)	0.46 (-8.23-9.15)	16 (-43-74)	34.63 (-113.93-183.19)	-2.34 (-10.10-5.41)	-242 (-592-109)	-0.68 (-8.58-7.22)
Admission eGFR	-0.06 (-0.08--0.05)	-0.10 (-0.20-0.01)	-1 (-2--0)	-1.00 (-2.79-0.79)	-0.06 (-0.15-0.03)	-8 (-12-3.6)	0.00 (-0.09-0.10)

**Table 3. Multivariable Analysis of Select COVID-19 Directed Interventions**

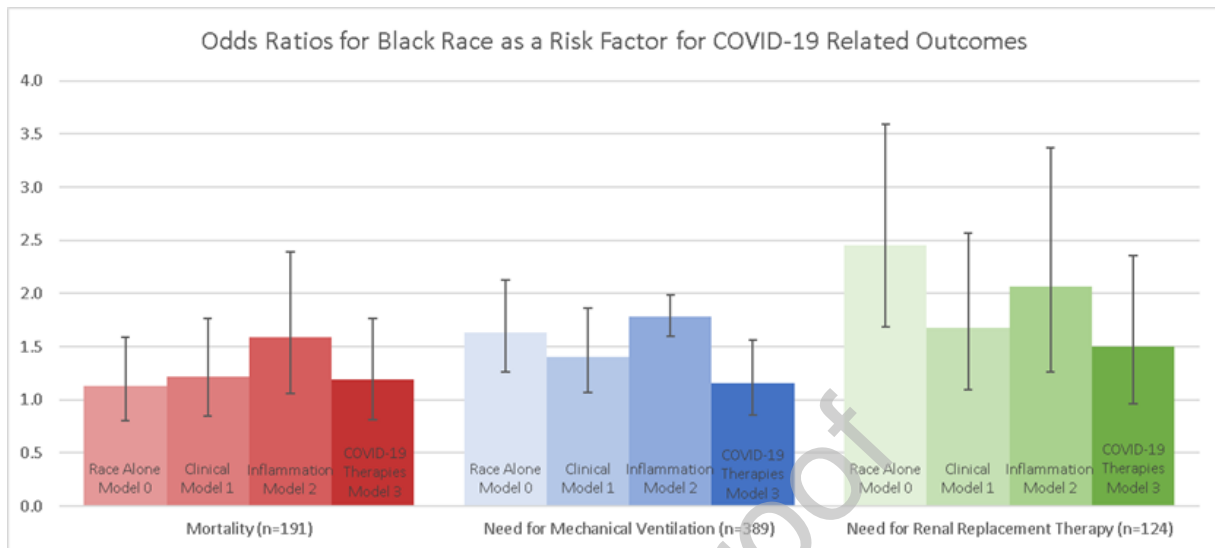
	Intervention, $\beta$ (95%CI)		
	Remdesivir	Corticosteroids	Clinical Trial Enrollment
Black Race	<b>0.24 (0.18-0.32)</b>	<b>0.45 (0.35-0.58)</b>	<b>0.47 (0.32-0.68)</b>
Age, per 1 year	1.02 (1.01-1.03)	1.00 (0.99-1.01)	1.00 (0.99-1.02)
Female Sex	0.88 (0.70-1.11)	0.89 (0.71-1.12)	0.72 (0.54-0.97)
Body-Mass Index, per 1 kg/m <sup>2</sup>	1.01 (0.995-1.03)	1.00 (0.99-1.02)	1.02 (1.00-1.04)
Diabetes Mellitus	0.91 (0.70-1.18)	0.94 (0.73-1.21)	0.88 (0.64-1.21)
Hypertension	0.93 (0.71-1.23)	1.03 (0.81-1.39)	0.97 (0.69-1.35)
Coronary Artery Disease	1.05 (0.75-1.47)	0.98 (0.70-1.36)	0.94 (0.61-1.45)
Heart Failure	0.81 (0.56-1.19)	0.91 (0.63-1.31)	0.43 (0.24-0.77)
eGFR at Admission, per 1 ml/min	1.00 (1.00-1.01)	1.00 (0.99-1.00)	1.00 (1.00-1.01)



**Figure 1. Use of COVID-19 Related Therapies According to Race.** Horizontal bar graph demonstrating the proportion of Black and non-Black patients receiving each therapy with associated P-value from univariable analysis.



**Figure 2. COVID-19 Directed Interventions in Black patients Prior to and After EUA Approval of Remdesivir.** Clustered bar graph showing proportions of Black patients pre- and post-Emergency Use Authorization of remdesivir (periods 1 and 2, respectively), in addition to the proportion of non-Black patients in period 2 receiving COVID-19 therapies. P-value is derived from the comparison between Black patients and non-Black patients in their receipt of COVID-19 therapies in period 2.



**Figure 3. Odds Ratios for Black Race as a Risk Factor for COVID-19 Related Outcomes.**

Bar graphs showing the odds ratios for Black race for mortality, need for mechanical ventilation, and need for renal replacement therapy during hospitalization for COVID-19. Model 0 includes Black vs. non-Black race only; model 1 includes race, sex, age, BMI, diabetes mellitus, hypertension, coronary artery disease, heart failure, chronic kidney disease, and eGFR on admission; model 2 adds CRP to model 1; and lastly model 3 includes the use of remdesivir and corticosteroids. Error bars denote 95% confidence intervals. Dashed line denotes odds ratio of 1, with non-Black race being the reference.